THE INFLUENCE OF GREECE ON SCIENCE AND MEDICINE

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IT may be said without inaccuracy that in ancient Greece we find either the beginnings or the indications of every phase of intellectual activity characteristic of our present civilization, not excepting either the study of science or the practise of medicine. Were one of the Greeks of the age of Archimedes to appear to-day in the midst of our university activities, he would be surprised not at our study of philosophy or logic, or ethics, or mathematics, or languages, but at the state of those applied sciences which deal quantitatively with the various forms of natural energy. That we can measure the force of gravitation, or the rate of transference of heat or the quantity of heat transferred, that we employ the expansive force of steam, or the differences of electrical potential in order to make things move—these would indeed amaze him. Aristotle, for instance, would be dumfounded to be told that an egg could be hatched by the artificial heat of an incubator, for he taught that there was a very great difference between heat of physical and of animal origin; in fact, that they were absolutely distinct in their essence.

That one might contemplate natural happenings and distinguish their essence from their accidents, the Greek mind could comprehend; but what is so entirely modern is the way in which we have liberated and utilized the natural forces and incarnated energy, harnessed force to matter, and made energy manifest by transmuting one form of it into some other.

Man's muscles are of so much less account to-day than any ancient Greek would have dreamed it possible.

The Greek contributions to the science of mathematics are matters of common knowledge: almost every one knows that Euclid is the name of a mathematician and not of a subject; although we have heard of a schoolboy who, on being shown a bust of Euclid, asked, "Why didn't they have one of good old Algebra too?" The Greek did what he could—and it must be confessed very successfully—to study the properties of space, since it was denied him to investigate the forces operating in that space. He developed the science of pure spatial relationships; and although the name of Euclid is the best known of the geometers, it is far from being the only one. The Pythagoreans had investigated dimensions and quantities; Apollonius of Perga, conic sections, Archimedes mechanics, Heron hydrostatics, Diophantus arithmetic and al-

gebra; Eudoxus and Hipparchus, astronomy. Grecian architecture was the outcome of scientific principles just as much as of the perception of the beautiful. The columns of the temples were so constructed as to appear from the ground correct in outline and perspective, although in many cases they were neither vertical nor were their sides parallel. Euclid gives a full treatment of the mathematical principles of stereoscopic vision, as also does Galen.

If science is knowledge based on or flowing from exact thinking, the Greeks possessed such science, and laid down for all succeeding generations the philosophical basis for the superstructure.

There were natural philosophers as distinguished from metaphysicians from the earliest times. Aristotle and his pupils subsidized by Alexander the Great made vast collections of facts as truly empirical as those of any laborious collector or systematist of the present day. This spade-work in science was certainly less congenial to the Grecian mind than speculation; but some one had to do the spade-work and even that was not shirked. To the Greek mind the mere specialist or technician would have been deemed a monstrosity or a barbarian. To a person to-day who had acquired the facts of chemistry, let us say, without a knowledge of logic, mathematics, metaphysics, music, astronomy and modern languages, the Greeks would never have given the name of "scientist."

The Greeks cultivated the objective sciences with conspicuous success; they gathered facts in astronomy, optics, geography, zoology, embryology, botany and medicine, in very much the same general way that we do now. Without instruments of precision, they observed so precisely as to predict eclipses successfully. The universe, the environment, was to the Greeks a constant source of interest and of material for analysis; and this study of nature did not in the least impair their contemplation of the beautiful, the powerful, the graceful or the symmetrical.

But when we say "the Greeks," we do not confine our attention to thinkers within the geographical confines of Greece itself, we must include such seats of intellectual activity as her colonies at Pergamos and at Alexandria. Euclid, who left a certain portion of mathematics so complete that nothing was added to it until the seventeenth century A.D., was a resident in Alexandria and he flourished in the reign of Ptolemy I., King of Egypt (Ptolemy Soter who reigned from 323 to 285 B.C.). Euclid, who may have been born about 300 B.C., was one of the chief ornaments of that learned society at Alexandria which one, nowadays, would call a university, for it included philosophers, astronomers, mathematicians, physicians and anatomists. Not, of course, that Euclid really was the author of all the books extant and lost which have been attributed to him; for Proposition 47 of the First Book (In every

right-angled triangle, the square on the hypotenuse is equal to the sum of the squares on the other sides) was the discovery of Pythagoras; while Theon of Alexandria is known to have added certain definitions on his own account.

But even when we deduct all those portions of Grecian geometry declared by scholars to be earlier or later than Euclid, we are left paralyzed in admiration of the mind of the one man who was author of what is left.

We have no details of the life of Euclid; only one of his sayings has come down to us. When Ptolemy asked him if a person could not understand geometry without reading all his books—an enquiry with which many school boys in all ages have been in the deepest sympathy—Euclid replied: "There are no royal roads to geometry," alluding to those straight roads in Persia which were reserved for the king alone to travel over.

After Euclid, probably the next best known Greek mathematician is Archimedes, who in his youth studied at the Alexandrian School. Unquestionably the most original of the Greeks, Archimedes invented appliances and enunciated principles which remain of the utmost utility at the present day. The endless or Archimedean screw, although not now used for the purpose for which it was originally devised (raising water from the hold of a ship), is the parent of such diverse mechanisms as screw-nails and the steam-turbine. Archimedes made the first planetarium. His "Eureka" on discovering a method to detect alloy in the gold crown of Hiero of Syracuse, has become a hackneyed phrase. While we need not believe all that was told of him, of his engines for prolonging the siege of Syracuse, of the mirrors with which he set fire to the ships of the Roman fleet, etc., yet we may freely admit Archimedes to have been a mathematician and engineer of the first rank. The Archimedean principle of flotation underlies the possibility of things heavier than water floating in water. One of the sayings of Archimedes is in praise of the lever, a mode of the application of force which we have good reason to believe was known to the Egyptians long before Greece was civilized. Archimedes wrote, or to his inspiration are attributed, quite a number of books on pure mathematics, both of surfaces and solids, one of them, a treatise on the center of inertia, being of practical value at the present day. This book is regarded as the foundation of the theory of mechanics and it is a great advance on what Aristotle wrote on the same subject. By his own desire, the figure of a sphere within a cylinder was engraved on his tomb, for it was the relationship of these which Archimedes considered his greatest discovery. Archimedes was killed by a Roman soldier on the fall of Syracuse in 212 B.C. Cicero in 75 B.C. found the tomb overgrown with vegetation. Hero of Alexandria in his "Pneumatica" describes at least two devices

where either hot air or steam was made to do mechanical work. The one is a primitive type of steam-turbine, the other is the prototype of a class of engine which only after many centuries became practically useful.

Probably astronomy of all the objective sciences was that which the Greeks cultivated most successfully. This is not the occasion on which to relate even in epitomized form the evolution of astronomical knowledge among the ancients. From Thales of Miletus, who lived about 600 years B.C., to Ptolemy who flourished at Alexandria, about the 130th year of our own era, the knowledge of the behavior of the heavenly bodies had become increasingly more exact. Thales predicted an eclipse which "came off," if we may apply so irreverent a phrase to such event, on May 25, 585 B.C. Not that Ptolemy was the greatest, because one of the latest, of the Grecian astronomers. The discoveries of Hipparchus of Rhodes, in the opinion of modern astronomers are much more important. Not only was the observation of the eccentricity of the lunar orbit made by Hipparchus, but his observations on the motions of the moon became the data which enabled Dr. Halley in the eighteenth century to apply a most delicate test—the acceleration of the mean lunar motion—to Newton's great law of universal gravitation.

But the astronomical system of Pythagoras was actually nearer to the truth than was the Ptolemaic, for, for one thing, it made day and night depend upon the earth's rotation. He postulated a proper motion for the earth, and was thus more correct than Ptolemy. The system of Copernicus was more similar to the earlier than to the later Greek view; and, indeed, it was one of the charges brought by the church against Copernicus that his system was heathen and "Pythagorean." Anaximander made the first map of the heavens.

While we cannot speak of the science of chemistry as having existed in classical ages, since by "chemistry" we mean nothing earlier than the time of Van Helmont, yet every one knows that the Greeks speculated on the ultimate constitution of matter and on the substance of the universe with as much zest as they did on the constitution and nature of mind. The concept of the atom is purely Greek. Doubtless Dalton meant by "atom" something much more definite than did Leucippus or Democritus; but we cannot admit that Dalton's conception of the ultimate structure of matter was, as an intellectual analysis, any more subtle than that other which was the earlier by two thousand years.

Both Thales and Anaximander spoke of a universally distributed, primitive world-stuff, whether moisture, caloric, ether, was not determined, some one thing eternally abiding although its forms were many and evanescent. This does not differ essentially from the modern conception of the all-pervading ether whose properties underlie the forms of grosser matter.

Possibly Pythagoras is best known to people generally as the originator of the doctrine of metempsychosis, the transmigration of souls. To do penance for sins, the soul of a man might have to inhabit the body of a lower animal, *i.e.*, undergo a lower reincarnation. You remember when Malvolio is in prison[1] the clown, disguised as a priest, asks him:

C. What is the opinion of Pythagoras concerning wild-fowl?
M. That the soul of our grandam might haply inhabit a bird.
C. What thinkest thou of his opinion?
M. I think nobly of the soul, and in no way approve his opinion.
C. Fare thee well, remain thou still in darkness; thou shalt hold the opinion of Pythagoras ere I will allow of thy wits and fear to kill a woodcock lest thou dispossess the soul of thy grandam.

So that the origin of this joking was, by Shakespeare's day, already 2,000 years old.

The writings of Aristotle which deal with zoology and embryology are so well known that they need only be mentioned at this time. Of course it would be easy to show in how many things he was mistaken in regard to animal structure and function, nevertheless he was the first systematic student of zoology.

Long before Aristotle's time, however, Thales (639–544 B.C.) had speculated that all kinds of life, animal and vegetable, were derived from some one, common, living substance, thus anticipating our conception of protoplasm by about twenty-three centuries.

Empedocles of Agrigentum (504–443) wrote on the development of the fetus, and gave us the terms amnion and chorion which are in use at the present day. Anaxagoras had pondered on the power which the various organs of the body have of absorbing different forms of nourishment from the common blood. It is an unsolved problem yet.

No doubt there was the practise of the healing art before Hippocrates, just as there were poets before Homer. A learned German has collected all the allusions to physicians or the healing art in Greek poetry before the time of Hippocrates. It appears that such medical knowledge as existed before Homer was all of Egyptian origin. Homer mentions bones, sinews and intestines. He alludes to wounds and to the activities of surgeons with the army in the Troad, but never mentions internal diseases. He speaks of a woman Agamede who knew of all the healing herbs, and of Helen giving Telemachus nepenthe or the drink of oblivion. The onion, honey and wine are mentioned as drugs; and the bath followed by inunction as a therapeutic measure. Homer names two medical men, Machaon and Podalirius, sons of Asclepios, an unrivalled physician. Of the former he said:

A wise physician skilled our wounds to heal
Is more than armies to the public weal.

[1] "Twelfth Night," Act IV., Sc. II.

That Xenophon, for example, recommended black as a restorative in cases of snow-blindness, does not entitle us to suppose that therefore Xenophon had any medical knowledge.

Hippocrates the Great was certainly the first in Greece to commit to writing a body of knowledge dealing with the diagnosis, treatment and prognosis of disease.

It is usual to trace the origin of Greek medicine to the worship of Asclepios (Latiné, Æsculapius) the God of Healing, son of Apollo. The cult of Asclepios was certainly very old and probably modelled on Egyptian lines. Sick people were brought to the temples of Asclepios just as to-day in Roman Catholic countries invalids are brought to shrines, or in all countries to spas or watering-places.

The priests of Asclepios or the Asclepiadae were not physicians so much as men who mingled with their religious activities a considerable amount of common-sense regarding the therapeutic power of mental suggestion. Hippocrates, who was not an Asclepiad but the chief personage at the medical school of the island of Cos, belongs to the age of Pericles. It is proper that in the golden age of Greece's history, the Father of Medicine should have arisen. He is supposed to have been the son of Heraclides, an Asclepiad, and the midwife Phænarete, and to have been born about 460 B.C.

The deservedly great fame of Hippocrates rests on his insistence that disease is a natural phenomenon, not some visitation of supernatural origin. He studies the sick man as a whole, entirely in the modern spirit, recognizing that we must observe closely in order first to learn the facts of the ailment, obtaining the natural history of the disease, and must recognize all the time that nature is in the main striving towards the recovery of the health. Of course some previous theoretical guidance was assumed necessary, but Hippocrates came each day to a case like an unbiased natural philosopher approaching some problem new to him.

In its Latin dress of vix medicatrix Naturæ, the healing tendency of living matter is familiar to most of us. A great deal of the so-called Hippocratic writings are not from the hand of Hippocrates, many being later than his time; but enough that are genuine remain to convince us how high were the ideals of Hippocrates in the sphere of morals, no less than in that of medicine. The oath of Hippocrates is a noble document. Whether it was composed by Hippocrates himself may be doubted, but it accurately represents the high aims that Hippocrates had before him in his practise. Composed as it was in times long pre-Christian, it is to-day as worthy a guide for the conduct of the physician as can be found in any literature; and its obligation to keep professional secrets may well be pondered over by those members of our profession, who, in neglecting this part of the oath, are guilty of a grave offence against

the ethics of their calling. I need hardly say that the "Aphorisms of Hippocrates" have long ago taken their place immovably amongst the world's classics.

Many more doctrines in medicine are due to Hippocrates than most people, even most physicians, believe. The doctrine of humors, of the healing power of nature, of critical days (this latter the result of Pythagorean influence), are all Hippocratic; while "Hippocratic succession" and the "facies Hippocratica" have been an integral part of medical terminology for 2,300 years. Hippocrates recognized four humors, blood, phlegm, yellow bile and black bile, a proper or due mixing of which constituted good health, an undue predominance of any one, disease, notions which gave rise to the "humoral pathology" which dominated medicine for ages, and which in another sense dominates it still. Hippocrates, as one might suppose, had a much better knowledge of the bodily organs than of their functions. He certainly confused nerves, tendons and ligaments, a mistake quite excusable, seeing that they are all very similar in the dead body of a lower animal; for there is no evidence that Hippocrates examined the body of any animal during its life. In all probability he did not even dissect the human body. The bare idea of doing so would have been repugnant to the beauty-loving Greek. Some of the Hippocratic physiology is not far from the truth, some of it far indeed. He knew that food was "cooked" in the stomach, that a lesion on one side of the brain produces paralysis on the opposite side of the body, that the heart contains blood, that the liver prepares blood and bile, and that the lens of the eye has to do with vision. He knew that local fatigue could, if sufficiently developed, produce general fatigue. Hippocrates divided diseases into chronic and acute, endemic and epidemic, distinctions we recognize yet.

Again the terms angina, catharsis, catarrh, enema, paracentesis, glaucoma, gangrene, syncope, hemorrhage, "healing by the first intention," are all terms of Hippocratic medicine in use to-day. The Father of Medicine wrote on the principles of surgery, obstetrics, dietetics and treatment. As regards treatment he was thoroughly eclectic, using every means in his power to restore the sick man to health. The modern treatment of fevers is essentially Hippocratic; febrile patients were allowed to drink water or barley water; later medicine, arriving at the doctrine that water was injurious to the fevered organism, practised much unconscious cruelty and undoubtedly sacrificed many lives.

Hippocrates is the all-round physician; he knows all that has gone before in his science. "The physician," he says, "must know what his predecessors have known if he does not wish to deceive both himself and others." He studies everything concerning his patient, his heredity, the objective signs, and the subjective when he can elicit them. His profession is to him as art to the artist: "Where is love for art, there

is also love for man." Hippocrates is the good physician, at the very ethical antipodes from the quack or mere drug-prescriber. His is the large, sympathetic, wise, tactful, kindly outlook not so much towards disease as the diseased man; he is the exponent of the highest Greek culture in the realm of applied medicine. Although the schools of Cos and of Cnidos continued for a long time to exert their influence, with Hippocrates and Pericles passed away the brightest hour of Greece's glory at least in matters medical. The succeeding century was comparatively sterile as regards contributions to practical medicine.

For although Plato wrote on certain matters belonging, as we should now think, to medical science, his influence built up the school of the Dogmatists whose chief tenet was that reflection should come before experience. In fact, philosophizing about disease rather than the observing of patients became the vogue in some quarters, so that much post-Hippocratic medicine is clinically barren. It may be doubted whether Plato understood more perfectly than Hippocrates any bodily function, save perhaps the respiration. Plato's doctrine of the soul as a separate existence, residing in the "marrow" (presumably the central nervous system, not the bone-marrow), concerns us here only in so far as we see specified one of the earliest seats of the soul and that a neural one. Chrysippus of Cnidos (born B.C. 340) regarded the soul as being in the blood, on which account he would not employ venesection, but did use tourniquets on bleeding limbs. Both Pythagoras and the Egyptians had taught that the soul was in the blood, a view consonant with that in the Old Testament, "for the blood is the life." According to Professor Ostwald, Plato is responsible for all the difficulty in connection with the problem of the relationship of mind to matter. His words are:

> Through the age-long effect of the blunder committed by Plato in making a fundamental distinction between mental life and physical life, we experience the utmost difficulty in habituating ourselves to the thought of the regular connection between the simplest physiological and the highest intellectual acts.

Praxagoras of Cos was the teacher of Herophilus, himself one of the best known teachers of that important school of medicine or university at Alexandria which was founded by Ptolemy Soter and continued to be a source of Hellenic illumination as late as the second century of our own era.

Praxagoras it was who, first distinguishing arteries from veins, taught that in health the arteries did not contain blood, but that, as blood always flowed from them in wounds, they must have taken it up from the flesh round about.

The other famous name of the Alexandrian Museum was Erasistratus, whose teacher had been Metrodorus, the son-in-law of Aristotle. By the mention of that great name, probably the greatest of antiquity, we are introduced not only to the encyclopedist of Hellenic science, but to

an influence which exerted itself in ever increasing force almost to within our own day. For, as Professor Mahaffy says, the man whose writings dominated European thought in logic and in the mental and physical sciences for more than a millennium, and who came within a very little of being canonized by the church of Rome, was probably the greatest of the ancients. Aristotle was as much the creator of the science of logic as he was of the sciences of zoology, embryology and comparative anatomy. He discovered the heart of the unhatched chick (punctum saliens) and saw it pulsating. He named the great artery that proceeds from the heart, aorta, by which term it has ever since been known. He adopted the Hippocratic classification of the humors, but did not rectify the confusing of nerves with tendons. He distinguished arteries from veins; but he described a vein from the liver to the right arm, and another from the spleen to the left arm, hence blood letting on the same side as the organ affected was especially valuable. This error gave rise to a long controversy during the Middle Ages as to where to open a vein; entire medical schools, even whole universities, being ranged on one side and on the other.

To Aristotle the heart is the acropolis of the body, and he makes the neura or tendons arise from the heart. The nerves, as canals leading from the brain, he understands, but, believing the brain to be bloodless, he attributes no functions of any great importance to it. The object of respiration he imagined to be the drawing in of cold air to cool "the innate heat of the heart," a view which was held until the time of Harvey. As Professor Driesch says:

> What inspires us with the highest admiration of the great Greek thinker is the way in which he perpetually and manifestly struggles for clearness in this hardest of all Nature's problems (life).

Aristotle frequently writes with his eye on the medical profession. He says:

> It is the business of the naturalist to know also the causes of health and disease, hence most naturalists see in medicine the conclusion of their studies; and of physicians, those at least who display some scientific knowledge in the practise of their art, begin the study of medicine with the natural sciences,

so that custom at least is as old as the time of Aristotle.

But this is, indeed, a late date to be telling people what Aristotle did for every department of knowledge to which he had access. His writings were the academic text-books of the Middle Ages; and the study of them is by no means dispensed with at our seats of learning to-day.

From about 300 B.C. onwards for several hundreds of years, medicine flourished in particular in two Greek colonies, Alexandria in Egypt and Pergamos in Mysia. Both were populous and rich cities, centers of all manner of intellectual and artistic activities.

Alexandria beecame the seat of the most important university of antiquity: all the branches of study were represented there, and anatomy and medicine were taught with a thoroughness nowhere else attained except at Pergamos. To have studied at Alexandria was, as late as the end of the fourth century A.D., the highest recommendation a physician could give.

Herophilus of Chalcedon (335–280), who was physician to Ptolemy I. (323–284), and Erasistratus of Iulis, in later life physician to Ptolemy Philadelphus (284–246), may be regarded as the founders of the Alexandrian school of medicine. The views of these two leaders were not identical, so that in course of time two distinct lines of medical dogma became established, those of the Herophilists and of the Erasistratans, respectively.

The advances in medical knowledge made at Alexandria were due to the untrammelled study of practical human anatomy. Herophilus, it is said, went so far as to dissect living persons, criminals assigned to him by the authorities.

Herophilus left his impress on anatomy for all time: he discovered the meeting-place of the cerebral sinuses in the occipital region, naming it the torcular; he gave its name to the duodenum, he called the pulmonary artery the vena arteriosa, and the pulmonary vein, the arteria venosa. He correctly taught that the pulse is due to the heart's systole, and he knew that arteries contain blood. He described the liver, the oviducts, the hyoid bone and many details in the anatomy of the eye. Herophilus traced nerves to and from the central nervous system, and, describing the brain, gave to an appearance in the Fourth Ventricle the name of Calamus Scriptorius which it has ever since retained. Herophilus believed the soul resided in the Fourth Ventricle. Herophilus discovered the receptaculum chyli and certain large lymphatics which were rediscovered only in the seventeenth century. Erasistratus made even a more thorough study of the brain than did Herophilus, and attributed mental diseases to lesions of that organ or of the cerebellum. Though he denied that the arteries contain blood, Erasistratus wrote with insight on paralysis, dropsies, liver disease, digestion, absorption and treatment both by drugs and by surgery. Erasistratus is remembered for having diagnosed the cause of the illness of Antiochus, son of Seleucus Nicator, whose physician he was. Erasistratus discovered that the prince was in love with his stepmother, Stratonice, because of his blushing and palpitation whenever that lady entered the room. Erasistratus was evidently a physiologist. Whether or not it was with a view of curing Antiochus, I cannot say, but Erasistratus prescribed marriage with Stratonice, for which advice he received a fee of $100,000.

The following belonged to the school of Herophilus; Demetrius of Apamea (276 B.C.), Collimachus (246 B.C.), Zeuxis of Laodacea, Dio-

scorides (40 B.C.) the physician of Cleopatra, and Aristoxenes (A.D. 79). Demetrius of Bithynia and Heron of Alexandria are well known names in Alexandrine medicine. Heron, a mathematician and physicist as well as physician, was a contemporary of Archimedes; he described a water-organ, the invention of his teacher Ctesibius.

The other great school of medicine in a Grecian colony which alone rivalled Alexandria in learning and culture was Pergamos, that same Pergamos where "Satan's seat is," as it is expressed in the address to the Angel of the church at Pergamos. The library at Pergamos was almost as famous as that at Alexandria: when Ptolemy Soter would not allow the exportation of papyrus from Egypt, the Pergamites used animal skins for their books, hence "parchment."

The age-renowned Galen was a graduate of the school at Pergamos, and the names of his teachers in anatomy and pathology survive to this day. He studied anatomy also at Smyrna under one Pelops, and for some time at Alexandria under Heraclianus. It was here, he says, he had the good fortune to see a human skeleton.

Claudius Galenus (to give him his Latinized name) was a Greek, he wrote in Greek, and his works were not translated into Latin until the fifteenth century. Galen, the son of an architect Nicon, was born at Pergamos in A.D. 130 and died in Rome, it is believed, about the year 200. Nicon, having had a dream bearing on his son's future, devoted him to a study of philosophy and medicine from as early as his fifteenth year. On returniing from his travels to his native city when he was about 28 years old, Galen was appointed surgeon to the school of Gladiators at Pergamos. Six years later he went to Rome where he lectured on physiology and on medicine, it would appear, on Hippocratic lines. He does not seem to have had very amicable relations with his colleagues, so he left Rome for a time and returned to Pergamos. After about a year's absence, he was recalled by the Emperor Marcus Aurelius to whom he became physician. Declining to accompany his master on his military expedition against the Marcomanni, Galen remained in Rome as physician to the Emperor Commodus. Though Galen cetrainly extended the knowledge of both structure and function beyond Hippocratic limits, he corrected, unfortunately, but few of the worst Hippocratic mistakes. It is doubtful whether he ever dissected the human body, for, as Vesalius pointed out, his anatomical descriptions apply chiefly to the monkey and the pig. Hence he commits the serious anatomical error of placing the human heart in the mid-line instead of to the left of it. In physiology he went far beyond Hippocrates, probably because he dissected so many animal types, and certainly because he examined some of them while still alive. Galen was known in Rome as the "wonder worker," on account of his having cured Commodus of a very severe illness.

If Hippocrates is the Father of Medicine, and Aristotle the Father

of Embryology, then Galen is the Father of Experimental Physiology. For he discovered that certain nerves were motor to certain muscles of the back, that the inferior laryngeal nerve was the nerve of voice, that the spinal cord was the conductor of impulses necessary for sensation, and that those crossed from one side to the other in it. Galen recognized thirty pairs of spinal nerves and seven pairs of cranial; he knew of sensory fibers in the abdominal sympathetic, and of the vital importance of the medulla oblongata.

The Galenical doctrine of spirits—natural, animal, vital—dominated physiology for fourteen centuries. Galen corrects Aristotle in making the nerves proceed from the heart, but at the same time he denies that the heart has any nerves of its own. He still thinks that in breathing, air is drawn into the chest to cool the heat of the heart, but he recognizes that "sooty" matter escapes from the lungs; he believes that the liver forms blood from digested food.

Galen knew tears to be the secretion of a gland and not an escape of aqueous humor: he discovered the six pairs of muscles of the eyes, and the muscles of the larynx. It was he who first described the Tendo Achillis, which quite explains why it has a Greek name. Galen's view of structure was always physiological, hence the titles of his works—"De usu partium corporis humani," "De motu musculorum," "De morborum causis." It was on the vascular system that Galen had least light. No notion of a circulation occurred to him. He thought that blood conveyed by the veins to the tissues was there used up in nourishing them. Crude blood with animal spirits from the liver, he thought, passed to the heart where the vital spirits were originated; animal spirits being produced as a further result of a refining process when the arterial blood had reached the brain. "Spirits" are too firmly embedded in our language for us ever to get rid of them. Galen imagined that the blood of the great pulmonary artery went to nourish the substance of the lungs, a notion of which Harvey pointed out the inherent improbability. Galen did, however, discover that an artery has three coats. He insisted that blood passed from the right to the left side of the heart through pores in the septum: Vesalius ridiculed this assertion, Harvey disproved it.

Galen regarded the heart as the seat of courage and the liver of love, a doctrine of local situations for mental attributes which has hardly died out up to the present time. The conceptions of the phrenologists are merely a development of this sort of thing, very different, however, from what is known as the localization of cerebral function. The liver and love were associated as late as Shakespear's time, when Pistol avers that Falstaff loves "with liver burning hot."[2]

Galen is responsible for the well-known doctrine of the four temper-

[2] "Merry Wives," Act II., Sc. I.

aments, the choleric, melancholic, sanguine and lymphatic. He also first gave the so-called four cardinal signs of inflammation: heat, swelling, redness and pain (calor, tumor, rubor and dolor). It is interesting to know that inflammation is possible without any of these four being present. Galen is less of the clinician and more of the systematist than Hippocrates; he is more of the anatomist and physiologist and less of the physician. His writings are very voluminous, for, besides on medical subjects he wrote on philosophical, grammatical, mathematical and legal topics. Forty-eight medical works alone are lost.

There is in Dalhousie University a Latin translation of the works of Galen by a Spaniard, Andreas Lacuna or Laguna, published at Strassburg in 1604, which edition is not in the British Museum.

In a sense it is a fact, then, that all the conceptions which were the intellectual working ideas of the Middle Ages were given to us by the Greeks. The Romans contributed practically nothing to the body of knowledge called science or to that called medicine: Pliny tells us it was beneath the dignity of a Roman to be a physician. Action, not contemplation, was characteristic of the Roman temper.

The fundamental concepts in astronomy, geometry and arithmetic, the entire sciences of logic and ethics; the speculations that were metaphysical, the notion of species, of evolution and yet of the oneness of living matter, the doctrines of the indestructibility of matter, of energy as inherent in matter, of the ultimate atomic constitution of matter were all products of Greek thinking.

The mind of Hellas supplied the materials of thought for subsequent speculation; and in very truth it touched nothing which it did not adorn. From the Greeks we inherit mental subtlety and the analytical aspect of the intellect. The Middle Ages added surprisingly little to this mass of mental currency, though some of the Hellenic coins were sadly defaced by excessive handling. Christianity did indeed introduce certain conceptions far enough removed from anything that the classical ages had attained to, but these were chiefly in the sphere of morals; they were not in objective science. The thinkers of the Ages of Faith made it their concern to mix the philosophy of Plato and the metaphysics of Aristotle with as much of the teaching of the Nazarene as they felt inclined. But with this aspect of things we have no concern to-day, for in "science" I do not for our present purpose include theology. The Middle Ages added no conceptions in regard to the universe or to life as fundamental or as comprehensive as those they inherited from prechristian times. There were, of course, workers like Albertus Magnus and Roger Bacon; but how little encouragement or approval the latter, at any rate, received from his ecclesiastical contemporaries is very well known. Until that awakening of the mind of man known as the Renaissance, not only had thinkers not added anything essential to the body of natural knowledge handed down from antiquity, but a very great deal that the ancients had taught was either distorted or totally forgot-

ten. I will, however, go much farther than that and say that in treatment, our profession up to as late as 100 years ago had forgotten a very deal of the practical therapeutic sanity of the Greeks, and had replaced it by a fantastic and revolting empiricism. The accounts of the doings of medical men at the death-beds of, *e.g.*, Charles the II. or Lord Byron are painful and humiliating, deserving of all the satire which a Molière could invent.

Vulgar representation and monkish credulity were soon mixed up with the few facts of medical learning which had survived the Fall of the Roman Empire. Astrological and alchemical verbiage obscured truths well known 300 years before Christ.

Hippocrates, Aristotle and Galen were not studied in the original, for the language of Greece was both dead and buried, but through Latin translations of Arabic translations. Not only did men not go back to Nature, they did not even go back to the authorities in their original tongues. Trifles of no medical or physiological importance were made the subjects of bitter debates that lasted through many generations.

It was the Arabian physicians who, through their translations of the Greek medical classics, preserved chiefly in Spain the learning of antiquity from suffering extinction during the earlier Middle Ages.

The grand objective simplicity of Hippocrates had given place to pseudo-philosophical and quasi-learned disquisitions about the principles of treatment. Certainly it is true that in every school of medicine the writings of Hippocrates and Galen were the text-books (as when in "The Merry Wives" Evans says, "He has no more knowledge in Hibbocrates and Galen," etc., and again "What says my Æsculapius? My Galen?") The lectures, in fact, consisted in readings from their works and discourses upon what was said therein. In course of time it became a heresy to discover an error in Galencial anatomy, a grave offence to propound a view of functional activity contrary to or beyond that indicated by the Pergamite. This intellectual bondage lasted until the middle of the sixteenth century, when by the boldness and industry of the Belgian Vesalius, and by the originality and candor of the English Harvey, the reformation of anatomy and physiology was accomplished. Vesalius' text-book and Harvey's discovery swept away forever the mental miasms of the Dark Ages. The error of the men of the Middle Ages was not that they revered too much the writings of the great ancients, but in holding that these were beyond criticism and contained the last words in matters medical. The writings of Galen they had allowed to become not merely a great text-book but a work of super-human authority. This was perhaps the greatest honor that the mediocre could pay to the master mind, and that mind the Hellenic. The golden gleam of the glory that was Greece failed not to light as with the kindly glow of a summer evening's sun the thousand years of those ages which, otherwise, would have been dark indeed.